



Tier 2 Overview

Decadal Survey Mission Development Symposium

Tire 1 and Tier 2 Progress

Steven Neeck

February 11, 2009



NRC Recommended Mid-Term Missions (Tier 2)



Mission	Mission Description	Orbit	Instruments
HyspIRI	Land surface composition for agriculture and mineral characterization; vegetation types for ecosystem health	LEO, SSO	Hyperspectral spectrometer TIR multispectral scanner
ASCENDS	Day/night, all-latitude, all-season CO ₂ column integrals for climate emissions	LEO, SSO	Multifrequency laser
SWOT	Ocean, lake, and river water levels for ocean and inland water dynamics	LEO	Ka-band wide swath radar C-band radar
GEO-CAPE	Atmospheric gas columns for air quality forecasts; ocean color for coastal ecosystem health and climate emissions	GEO	High and low spatial resolution hyperspectral imagers
ACE	Aerosol and cloud profiles for climate and water cycle; ocean color for open ocean biogeochemistry	LEO, SSO	Backscatter lidar Multiangle polarimeter Doppler radar



Tier 2 Mission Development Objectives



- Advance the science maturity and overall mission development
 - ❑ *Build on the results of the 2006-2007 mission studies*
 - ❑ *Define/refine scientific requirements*
 - ❑ *Develop mission/instrument requirements*
 - ❑ *Conceptualize mission/instruments*
 - ❑ *Mature mission-enabling technologies, assess, and downselect*
 - ❑ *Support cross and common mission activities*
 - ❑ *Develop partnering opportunities and conduct joint studies*
- Conduct the studies in an integrated fashion, led by the Program Scientist and Program Executive and coordinating across multiple levels within the Earth Science Community



Where do we expect to be by October 1, 2009?



- For each of the Tier 2 missions:
 - ❑ ***Quantitative assessment of the readiness to proceed to Formulation (Phase A)***
 - ◆ Draft level 1 science requirements, baseline mission concept, draft formulation authorization document, partnership evaluations, technology readiness level assessments
 - ❑ ***Mission maturation plan for FY10 and beyond, through launch and ops***
 - ◆ Life Cycle Cost, independent cost and schedule estimates



Tier 2 Study Execution



- ♦ Tier 2 studies are directed by the ESD and supported by the Earth Systematic Missions (ESM) Program Office at GSFC
- ♦ All mission development have a study management team, led from HQ ESD by the HQ Program Scientist and Program Executive, and including representatives from ESTO, data systems, applied sciences, and the ESM program office

MISSION		PROGRAM SCIENTIST	PROGRAM	DATA	APPLIED	RESOURCES	ESTO	ESM PO	
		PRIMARY	BACKUP	EXECUTIVE	SYSTEMS		SCIENCE		TECHNOLOGY
TIER 2	SWOT	LINDSTROM	ENTIN	NEECK	MAIDEN	HAYNES	BLACK	SMITH	BOLTON
	HYSPIRI	TURNER	LABRECQUE			HAYNES			
	ASCENDS	JUCKS	EMANUEL			TURNER			
	GEO-CAPE	JUCKS	BONTEMPI			FRIEDL			
	ACE	MARING	BONTEMPI			FRIEDL			



Tier 2 Community Activity

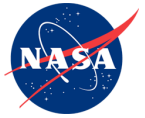


- ♦ Actively engaging the broad science and research communities to help definitize the objectives of the Tier 2 Decadal Survey mission concepts

June 19-20, 2008	ACE	Opening Science Workshop	Greenbelt, MD	Hal Maring	hal.maring@nasa.gov
July 23-25, 2008	ASCENDS	Opening Science Workshop	Ann Arbor, MI	Ken Jucks	kenneth.w.jucks@nasa.gov
August 18-20, 2008	GEO-CAPE	Opening Science Workshop	Chapel Hill, NC	Ken Jucks	kenneth.w.jucks@nasa.gov
October 21-23, 2008	HyspIRI	Opening Science Workshop	Pasadena, CA	Woody Turner	woody.turner@nasa.gov
November 6-7, 2008	ACE	Science Workshop	Salt Lake City, UT	Hal Maring	hal.maring@nasa.gov
November 10-14, 2008	SWOT	OSTST Meeting, SWG Meeting	Nice, France	Eric Lindstrom	eric.j.lindstrom@nasa.gov
December 8, 2008	HyspIRI SWOT	AGU Town Halls	San Francisco, CA	Woody Turner Eric Lindstrom	woody.turner@nasa.gov eric.j.lindstrom@nasa.gov
January 26-27, 2009	SWOT	Integrated Science Group Meeting	Paris, France	Eric Lindstrom	eric.j.lindstrom@nasa.gov
February 11-12, 2009	DS Tier 1 & 2	Decadal Survey Implementation Update	Washington, DC	Steve Volz	svolz@nasa.gov
March 10-12, 2009	ACE	Mission Formulation Workshop	TBD	Hal Maring	hal.maring@nasa.gov
June 22-24, 2009	SWOT	OSTST Mtg, SWG Mtg	Seattle, WA	Eric Lindstrom	eric.j.lindstrom@nasa.gov
August 11-13, 2009	HyspIRI	Science Workshop	Pasadena, CA	Woody Turner	woody.turner@nasa.gov
August TBD, 2009	GEO-CAPE	Mission Definition Assessment Workshop	TBD	Ken Jucks	kenneth.w.jucks@nasa.gov
September TBD, 2009	ASCENDS	Mission Definition Assessment Workshop	TBD	Ken Jucks	kenneth.w.jucks@nasa.gov



DS Tier 2 Funding & Status



- Assigned budget
 - Tier 2 missions (total): \$2.3M in FY08, \$10.6M in FY09
- FY08 and preliminary FY09 funding allocations and Center distribution based on input from mission Program Scientists
- FY09 CR1 funds Tier 2 at \$4.4M
- Funding levels for FY10 and beyond will be determined as part of the budget process, informed by the progress and outcome of these many studies

	FY08 (\$K)	FY09 (\$K)
304029.01.04 DECADAL MISSION STUDIES		
304029.01.04.04 – ACE		2,305
304029.01.04.04.01 - GSFC ACE	225	
304029.01.04.04.02 - LARC ACE	50	
304029.01.04.04.03 - JPL ACE	80	
TOTAL	355	
304029.01.04.05 – ASCENDS		2,000
304029.01.04.05.01 - GSFC ASCENDS	70	
304029.01.04.05.02 - LARC ASCENDS	29	
304029.01.04.05.03 - JPL ASCENDS	126	
TOTAL	225	
304029.01.04.06 – GEOCAPE		2,000
304029.01.04.06.01 - GSFC GEOCAPE	135	
304029.01.04.06.02 - LARC GEOCAPE	25	
304029.01.04.06.03 - JPL GEOCAPE	65	
TOTAL	225	
304029.01.04.07 – HYSPIRI		2,200
304029.01.04.07.01 - GSFC HYSPIRI	70	
304029.01.04.07.02 - LARC HYSPIRI		
304029.01.04.07.03 - JPL HYSPIRI	380	
TOTAL	450	
304029.01.04.08 – SWOT		2,063
304029.01.04.08.01 - GSFC SWOT	100	
304029.01.04.08.02 - LARC SWOT		
304029.01.04.08.03 - JPL SWOT	425	
TOTAL	525	
CROSS MISSION	500	TBD
DS TIER II TOTAL	2,280	10,568

Note. FY09 allocations are preliminary and will be revised as study plans mature.



ESTO Support to Tier 2 Missions

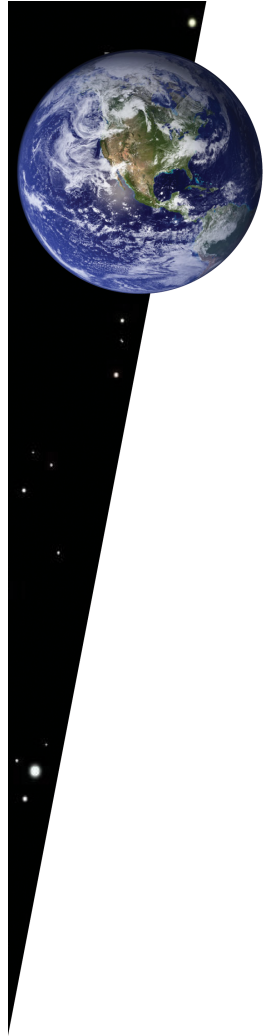


- Instrument Incubator Program (IIP)
 - ❑ *IIP Award Announcement April 2, 2008*
 - ❑ *10 of 21 awards*

- Advanced Component Technologies (ACT)
 - ❑ *ACT Award Announcement November 18, 2008*
 - ❑ *11 of 16 awards*

- Advanced Information Systems Technology (AIST)
 - ❑ *AIST Award Announcement December 10, 2008*
 - ❑ *10 of 20 awards*

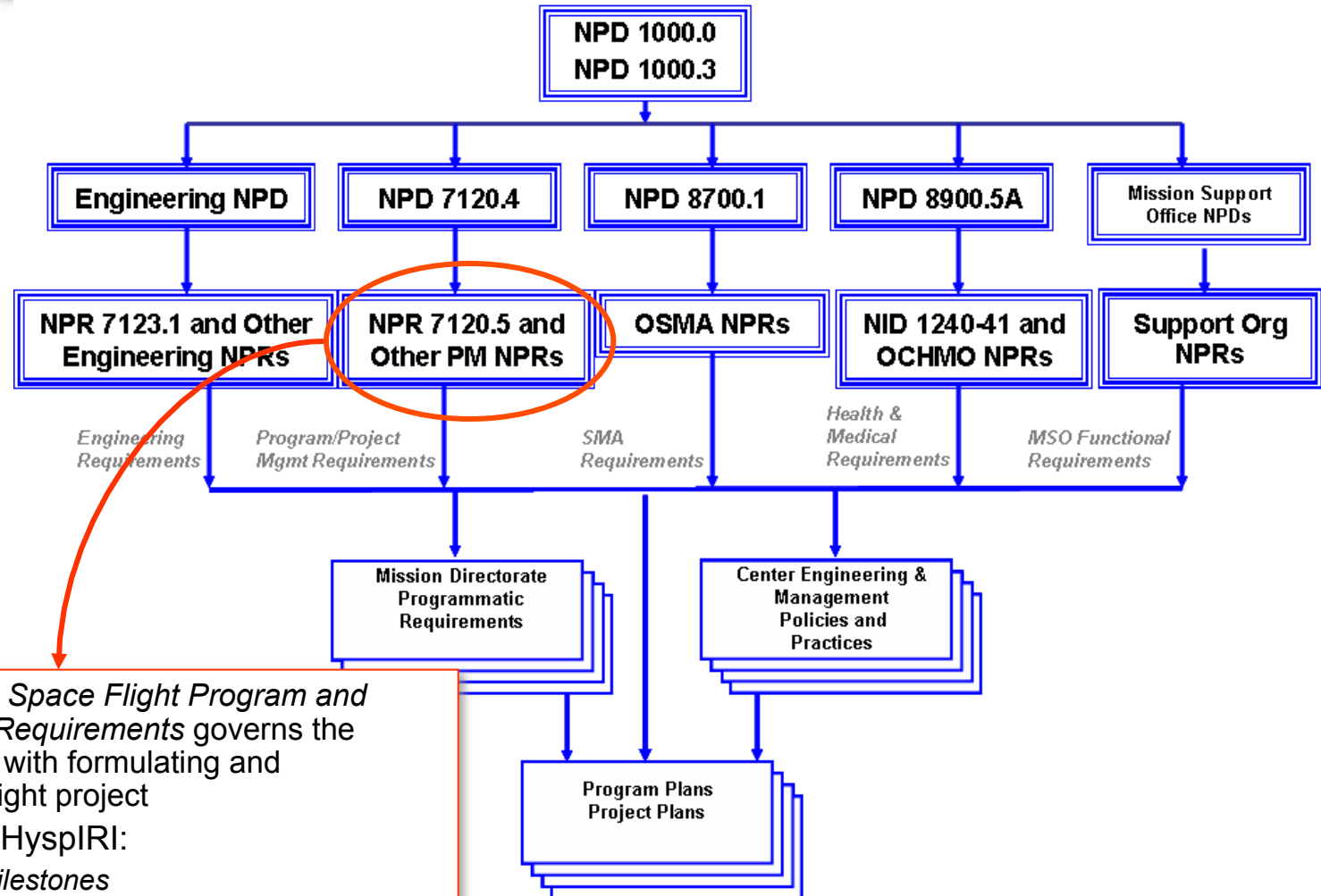
- Future plans for technology assessment support



BACKUP



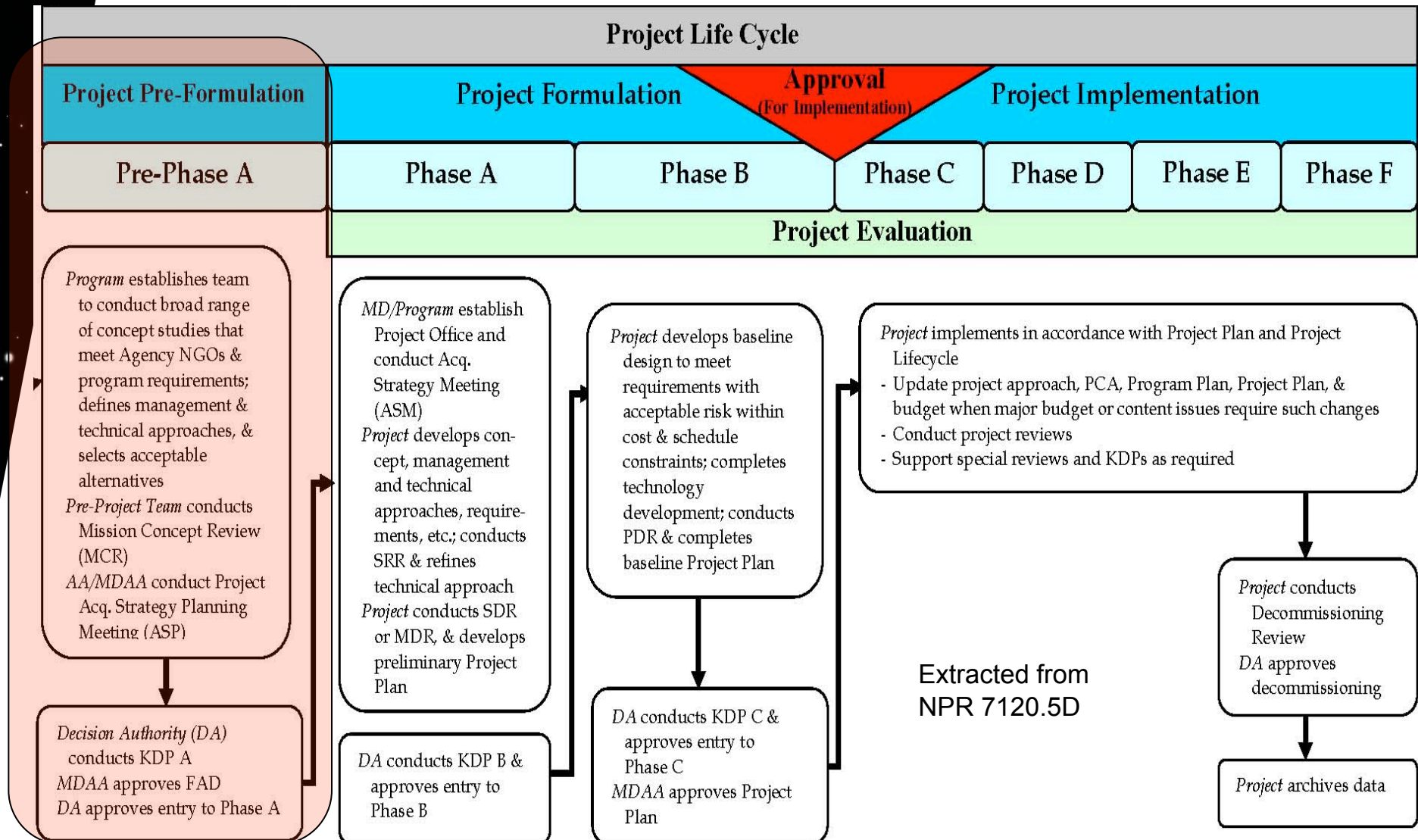
NASA Hierarchy of Directives



- ♦ **NPR 7120.5D - NASA Space Flight Program and Project Management Requirements** governs the processes associated with formulating and implementing a new flight project
- ♦ **Important details for HypIRI:**
 - Defines the Major Milestones
 - Identifies all requirements for each phase of the Project
 - Identifies all gate products for each phase
 - Defines roles and responsibilities
 - Identifies all major reviews



Flight Project Life Cycle





Mission Requirements for Pre-Phase A



Scope of Major Pre-Phase A Activities:

Headquarters

- ◆ Approve a Formulation Authorization Document
- ◆ Develop DRAFT Level 1 Requirements
- ◆ Conduct Acquisition Strategy Planning Meeting

Technical Activities:

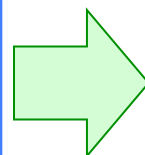
- ◆ Develop and document preliminary mission concepts
- ◆ Conduct internal Reviews
- ◆ Conduct Mission Concept Review Project Planning, Costing and Scheduling
- ◆ Develop and document a DRAFT Integrated Baseline, including:
 - *High level WBS*
 - *Assessment of Technology Readiness Levels*
 - *Assessment of Infrastructure and Workforce needs*
 - *Identification of potential partnerships*
 - *Identification of conceptual acquisition strategies for proposed major procurements*

KDP Readiness

- ◆ Obtain KDP A Readiness products
- ◆ Approval through the governing PMC

Areas the Science Community must work:

- ◆ Development of DRAFT Level 1 Science Requirements
- ◆ Support development of preliminary mission concepts
- ◆ Support the assessment of Technical Readiness Levels
- ◆ Identify potential partnerships





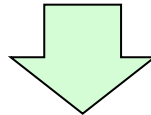
Key Pre-Phase A Questions



♦ What science MUST this mission achieve?

- ❑ *What specific measurements?*
- ❑ *To what accuracy?*
- ❑ *What are the required data products?*

Should be resolved ~ 12 months prior to KDP A



♦ What mission parameters can achieve the science?

- ❑ *What orbit (inclination/altitude)?*
- ❑ *Which instruments?*
- ❑ *What is the baseline mission duration?*

Should be resolved ~ 6 months prior to KDP A

♦ How can NASA achieve these measurements?

- ❑ *Are there other missions required/desired to achieve the science?*
- ❑ *Who can NASA partner with to achieve this mission?*





HyspIRI Study Status



- In advance of and then in response to the Decadal Survey, two separate mission concept studies were completed in FY2007.
 - *HyspIRI - Plant Physiology and Functional Types*
 - *HyspIRI - Thermal Infrared Scanner*
- An initial look at combined mission made last summer and continued refinement of the HyspIRI combined mission is underway.
- FY2009 study plan
 - *Refining HyspIRI mission requirements to ensure the scientific objectives can be met with sufficient cost, schedule and performance margin.*
 - Science requirements
 - Mission requirements
 - Instrument requirements
 - *Holding HyspIRI scientific workshop to engage science community and verify mission concept meets the science requirements*
 - October 21-23, 2008 Monrovia, CA
 - *Preparing for KDP-A (Phase A)*
 - Draft level 1 science requirements, baseline mission concept, cost, schedule, draft formulation authorization document, partnership evaluations, technology readiness level assessments



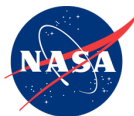
Science Management and Requirements Definition



- ♦ For all mission concepts, the overall mission science requirements and objectives will be defined by the Earth Science Division, with the discipline area Program Scientist as the lead and working closely with the individual mission concept science team
- ♦ For SMAP and ICESat II individual Science Definition Teams (SDT) will be selected based on competitive proposals solicited through a special Amendment to ROSES 2008.
- ♦ For DESDynI and CLARREO and Tier 2 Decadal Survey mission concepts, a similar approach is envisioned, but the SDTs will be initiated later as those mission concepts mature



Role of the Earth Systematic Missions Program Office



- ◆ All Decadal Survey Missions are directed missions and will be managed by the Earth Systematic Missions (ESM) Program Office, housed at GSFC.
 - *This is former EOS Program Office renamed and re-envigorated for the Decadal Survey*
- ◆ While housed at GSFC the ESM shall incorporate expertise from across NASA
 - *In particular including science and instrument expertise from LaRC and JPL*
- ◆ Level of interaction and involvement by the ESM PO with the individual mission development activities will vary with the maturity of the mission and mission study
 - *For all mission development activities the ESM PO will conduct cross-mission studies and investigate synergies, working with the ESD*
 - *For SMAP & ICESat II, the PO will have significant direct involvement*
 - *For CLARREO & DESDynI, the PO will co-lead the mission maturation activities with the PS/PE leadership team from HQ*
 - *For Tier#2 and Tier #3 missions, the individual mission activities will be led by the PS/PE, supported by the PO*



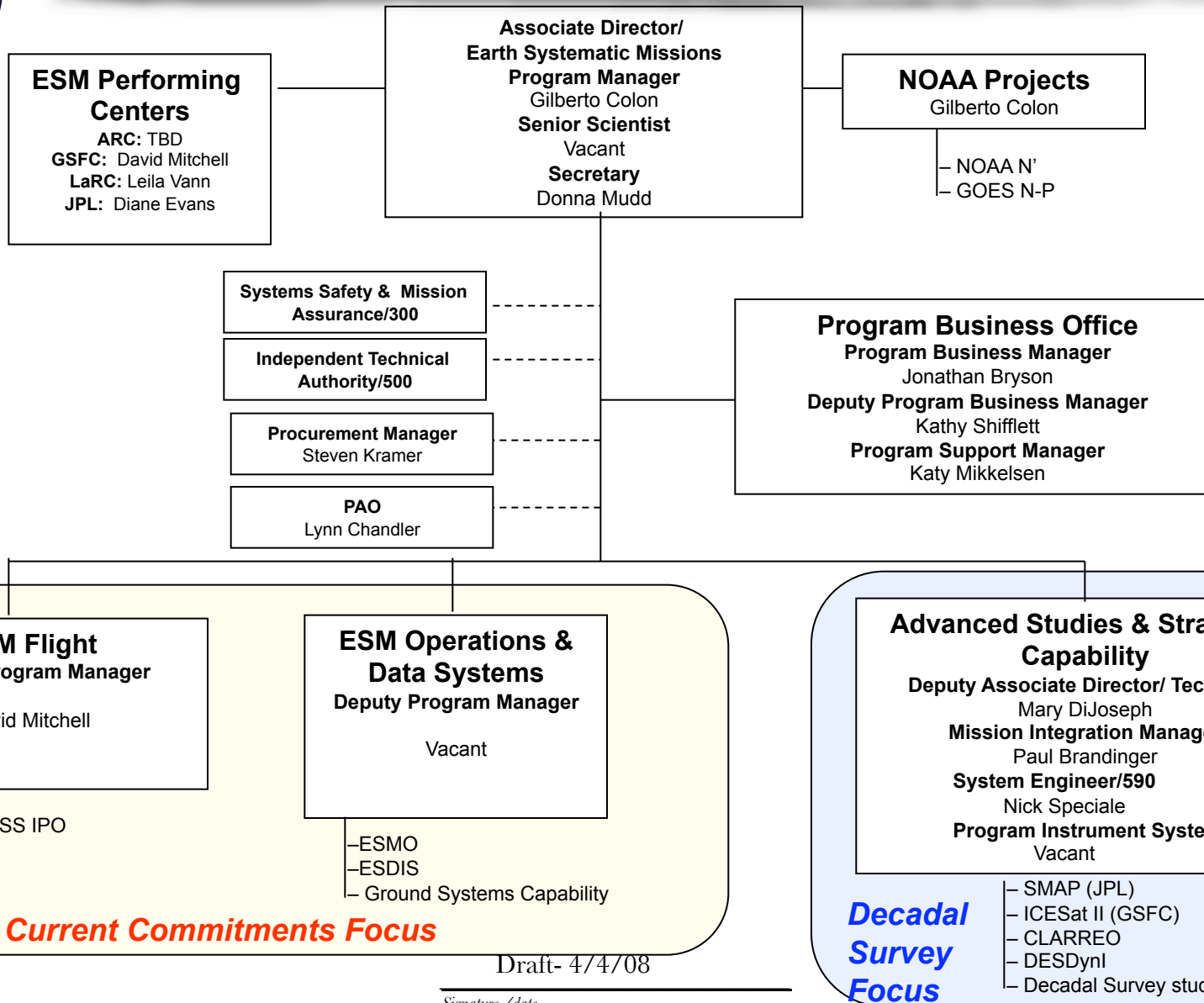
Cross & Common Mission Activities



- ◆ Identified under Cross Cutting items in WBS breakout and coordinated through the ESM Program office
 - *Data systems*
 - *GPS on each mission*
 - *Downlink capacity and impacts on data latency*
 - *Geodetic networks*
- ◆ Common Mission study features
 - *Launch vehicle availability and options*
 - *Technology assessments made with consistency*
- ◆ Instrument Incubator Program
 - *IIP Award Announcement April 2, 2008*
 - *Future solicitations*
- ◆ Advanced Component Technology solicitation released



Earth Systematic Missions Program Office

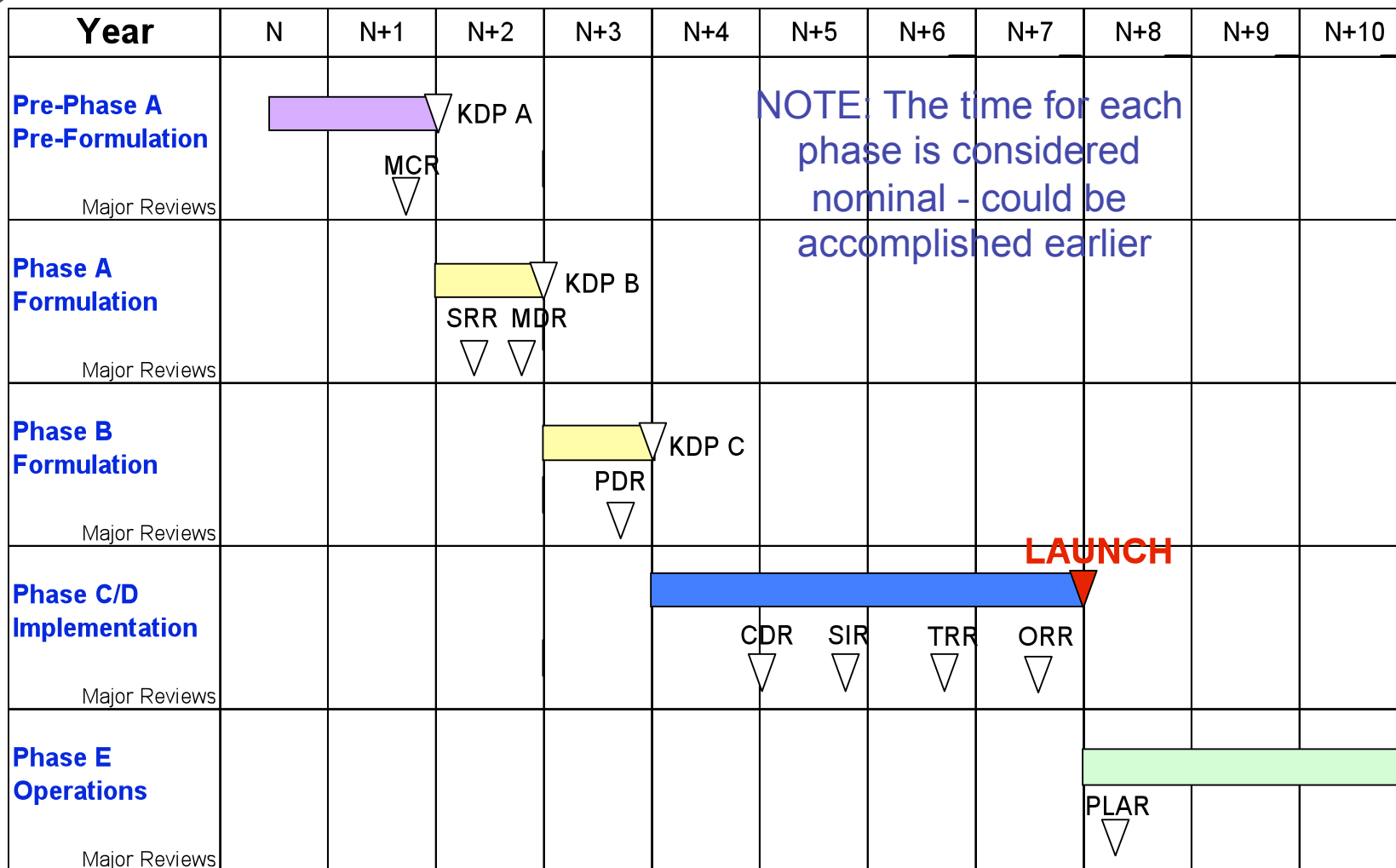


Draft- 4/4/08

Signature /date



Notional Mission Timeline





Mission Requirements for Phase A



Scope of Major Phase A Activities:

Headquarters

- ◆ Establish Baseline Level 1 Requirements
- ◆ Conduct Acquisition Strategy Meeting
- ◆ Initiate Interagency and International Agreements

Technical Activities:

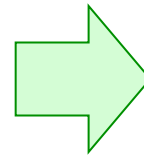
- ◆ Develop preliminary system level requirements
- ◆ Develop/document Baseline Mission Concept
- ◆ Develop preliminary mission operations concept
- ◆ Initiate technology developments
- ◆ Develop initial orbital debris assessment
- ◆ Conduct System Requirements Review
- ◆ Conduct Mission Definition Review

Project Planning, Costing and Scheduling

- ◆ Prepare a preliminary Project Plan
- ◆ Conduct required Integrated Baseline Reviews
- ◆ Develop/document preliminary Integrated Baseline
- ◆ Identify Export Controlled technical data

KDP Readiness

- ◆ Obtain KDP B Readiness products
- ◆ Approval through the governing PMC



Areas the Mission Science Team must work:

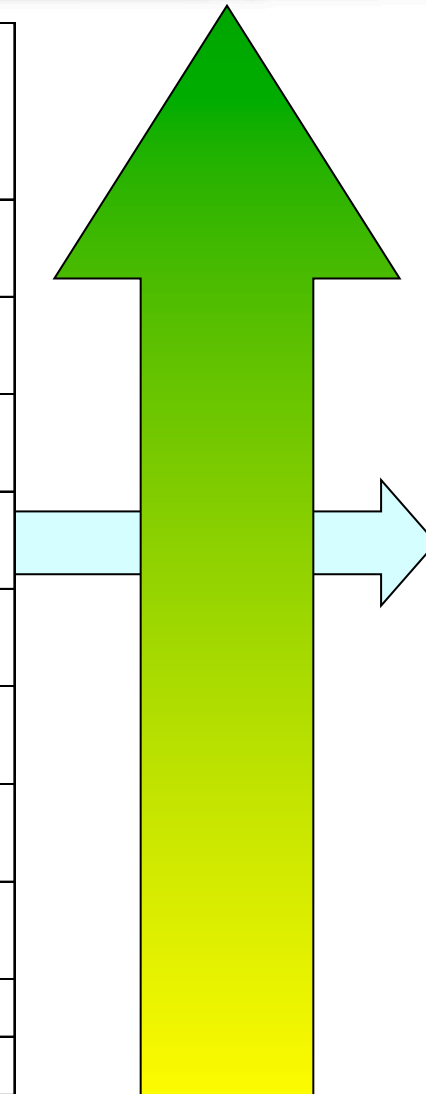
- ◆ Concur with Level 1 Science Requirements
- ◆ Support development of preliminary system-level requirements
- ◆ Support development of mission baseline concept
- ◆ Support Development of preliminary mission operation concept



Technology Readiness Level



Technology Readiness Level - (TRL)	Definition
9	Final product validated through successful mission operations (ground, airborne or space).
8	Final product in mission configuration qualified through test and evaluation
7	High-fidelity functionality and scaled form/fit demonstrated in its operational environment
6	Mid-fidelity functionality and scaled form/fit demonstrated in a relevant environment
5	Mid-fidelity functionality demonstrated in a relevant environment
5	Mid-fidelity functionality demonstrated in a relevant environment
4	Low-fidelity functionality demonstrated in laboratory
3	Analytical and/or experimental proof-of-concept demonstrated
2	Application and/or operating concept formulated
1	Basic principles observed and reported.



TRL levels defined in NPR 7123.1A

High Maturity

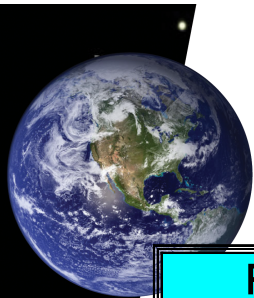
TRL 6 is the desired minimum level for integration of new technology

Low Maturity

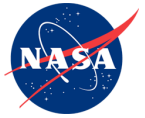


2007 Instrument Incubator Awards versus Decadal Survey Missions

	CLARREO	SMAP	ICESat-II	DESDynI	HypIRI	ASCENDS	SWOT	GEO-CAPE	ACE	LIST	PATH	GRACE-II	SCLP	GACM	3D-Winds	CLARREO-NOAA	GPSRO	XOVM
.../GSFC - column CO2, lidar																		
.../JPL - aerosols and clouds, polarimetric imager																		
.../JPL - clouds and precipitation, profiling radar																		
.../JPL - time-varying gravity, laser frequency stabilization																		
.../JPL - surface water and ocean topography, interferometric SAR																		
.../Ball - tropospheric winds, Doppler lidar																		
.../Aerospace - mineral and gas, TIR spectrometer																		
.../GSFC - column CO2, lidar																		
.../JPL - mineral/water resources, hyperspectral TIR spectrometer																		
.../LaRC - tropospheric winds, Doppler lidar																		
.../CU - radiation balance, UV-SWIR hyperspectral imager																		
.../JPL - T, water vapor, precipitation; microwave sounder																		
.../GSFC - ocean color, UV-SWIR radiometer																		
.../LaRC - radiation balance far-IR spectrometer																		
.../LaRC - boundary laser CO, gas correlation radiometer																		
.../GT - snow-water equivalent, X-band phased array																		
.../UWM - radiation balance, SI-traceable IR calibration																		
.../JPL - air pollution and coastal imaging, panchromatic FTS																		
.../JPL - atmospheric composition, microwave limb sounder																		
.../Ball - vegetation canopy, steerable lidar																		
.../GSFC - topography and vegetation structure, swath-mapping lidar																		



Major Pre-Formulation Events



Review	Description
Acquisition Strategy Planning (ASP) Meeting	The ASP meeting is integral to the annual budget submission process. The ASP meeting is structured to allow Agency senior management to review major acquisitions that evolve from Needs, Goals, and Objectives, as well as requirements introduced to the Agency from external sources (e.g., The President's Vision for Space Exploration) and internal sources (e.g., major acquisitions initiated by MDs/MSOs). The purpose of the ASP meeting is to identify and define roles and responsibilities of Mission Directorate(s), Centers, major partnerships, and associated infrastructure (workforce and facilities) with the focus on maintaining ten healthy Centers.
Acquisition Strategy Meeting (ASM)	The ASM applies to both programs and projects. The ASM should be convened as early as practicable and prior to partnership commitments. The purpose of an ASM is to obtain senior management approval of acquisition strategy (e.g., make-or-buy, Center assignments, and targeted partners) for programs and projects. The ASM meeting also delineates if a Procurement Strategy Meeting (PSM) is required for each acquisition under consideration. The Project ASM may be held in conjunction with the project SRR, but must be held prior to KDP B. The supporting materials for the ASM include appropriate program/project documentation that covers budget, schedule, requirements, and risk.



Major Formulation (Phase A/B) Events



Review	Description
Mission Concept Review (MCR)	The MCR will affirm the mission need and examine the proposed mission's objectives and the concept for meeting those objectives. Technologies will be assessed and identified. It is an internal review (SRB may not have been formed) that usually occurs at the cognizant organization for system development. ROM budget and schedules will be presented.
System Requirements Review (SRR)	The SRR examines the functional and performance requirements defined for the system and the preliminary program or project plan and ensures that the requirements and the selected concept will satisfy the mission.
Mission Definition Review (MDR)	The MDR examines the proposed mission/system architecture and the flow down to all functional elements of the system. Technology planning with off-ramps will be described. The preliminary description of the management approach and initial budget and schedule will be presented. Risk assessment and management will be presented as well as initial de-scope plan.
Preliminary Design Review (PDR)	The PDR demonstrates that the preliminary design meets all system requirements with acceptable risk and within the cost and schedule constraints and establishes the basis for proceeding with detailed design. It will show that the correct design option has been selected, interfaces have been identified, and verification methods have been described. Full baseline cost and schedules as well as all risk assessment, management systems and metrics will be presented.